

AMENDMENTS TO THE CLAIMS

The following is a complete listing of all claims in the subject application with the status of each claim being indicated in a parenthetical expression. Claims 1, 2, 5, 6, 8, 11, 12, 15, 16, 20, 21, 23, 30, 32 and 33 being amended herewith are presented with markings showing the changes made relative to the immediate prior version. Claims 3, 4, 7, 9, 10,, 13, 14, 17-19, 22, 24-29, 31 and 34-40 not being amended herewith and claims 41-45 being newly presented herewith are presented in clean version.

1. (Currently Amended) A plug tool for forming internally helically ribbed tube, comprising

a plug including a plug body for being rotatably disposed in a die orifice of a drawing die and having a central longitudinal axis, a plurality of external grooves equally spaced about said central longitudinal axis, and a plurality of external lands in alternating arrangement with said grooves, each of said plurality of grooves terminating at a forward groove end and at a rearward groove end on said plug body, each of said plurality of lands terminating at a forward land end and at a rearward land end on said plug body, said grooves extending longitudinally along said plug body at a helix angle to said central longitudinal axis and closely corresponding to internal helical ribs formed in tubing drawn longitudinally over and relative to said plug body in a forward direction through the ~~drawing die with~~ orifice as said plug body disposed rotates within the die orifice and the tubing, each of said plurality of grooves having a cross-section normal to said groove defined by a root surface and a pair of flank surfaces extending angularly outwardly away from one another from said root surface to land surfaces of adjacent ones of said lands, each of said pair of flank surfaces

including a forward flank surface facing in opposition to the forward direction of draw for the tubing over said plug body and extending angularly outwardly from said root surface at an angle, and a rearward flank surface facing toward the forward direction of draw for the tubing over said plug body, said rearward flank surface extending angularly outwardly from said root surface at an angle less steep than said angle of said forward flank surface ~~different angles.~~

2. (Currently Amended) ~~A~~ The plug tool recited in claim 1 for forming internally helically ribbed tube, comprising
a plug including a plug body for being rotatably disposed in a die orifice of a drawing die and having a central longitudinal axis, a plurality of external grooves equally spaced about said central longitudinal axis, and a plurality of external lands in alternating arrangement with said grooves, said grooves extending longitudinally along said plug body at a helix angle to said central longitudinal axis and closely corresponding to internal helical ribs formed in tubing drawn in a forward direction through the drawing die with said plug body disposed within the tubing, each of said grooves having a cross-section normal to said groove defined by a root surface and a pair of flank surfaces extending angularly outwardly away from one another from said root surface to land surfaces of adjacent ones of said lands, said flank surfaces extending angularly outwardly from said root surface at different angles, wherein said helix angle is 40°, a rearward one of said flank surfaces of each of said grooves defines a radial angle of 37°, and a forward one of said flank surfaces of each of said grooves defines a radial angle of 16°.

3. (Original) The plug tool recited in claim 2 wherein said grooves have a width and said land surfaces have a width at least substantially the same as said

width of said grooves.

4. (Original) The plug tool recited in claim 1 wherein said plug body comprises an intermediate length section disposed between a forward length section and a rearward length section, said intermediate length section defining an external cylindrical configuration, said forward length section being externally chamfered from said intermediate length section to a forward end of said plug body, said rearward length section being externally tapered from said intermediate length section to a rearward end of said plug body.

5. (Currently Amended) A The plug tool recited in claim 1 for forming internally helically ribbed tube, comprising
a plug including a plug body for being rotatably disposed in a die orifice of a drawing die and having a central longitudinal axis, a plurality of external grooves equally spaced about said central longitudinal axis, and a plurality of external lands in alternating arrangement with said grooves, said grooves extending longitudinally along said plug body at a helix angle to said central longitudinal axis and closely corresponding to internal helical ribs formed in tubing drawn in a forward direction through the drawing die with said plug body disposed within the tubing, each of said grooves having a cross-section normal to said groove defined by a root surface and a pair of flank surfaces extending angularly outwardly away from one another from said root surface to land surfaces of adjacent ones of said lands, said flank surfaces extending angularly outwardly from said root surface at different angles, said plug body comprising an intermediate length section disposed between a forward length section and a rearward length section, said intermediate length section defining an external cylindrical configuration, said forward length section being externally chamfered

from said intermediate length section to a forward end of said plug body, said rearward length section being externally tapered from said intermediate length section to a rearward end of said plug body, wherein said rearward length section is externally tapered at an angle of about 7° to an outer diameter of said intermediate length section.

6. (Currently Amended) The plug tool recited in claim 4 wherein said ~~external grooves~~ forward groove ends and said ~~external lands have~~ forward land ends, respectively, are located on said forward length section and said rearward groove ends and said rearward land ends, respectively, are located on said rearward length section.

7. (Original) The plug tool recited in claim 1 wherein said plug body comprises four or more of said external grooves and a number of said external lands equal to the number of said external grooves.

8. (Currently Amended) The plug tool recited in claim 1 wherein said plug body is integral and unitary with a connector comprising an externally threaded extension extending coaxially from said plug body in a rearward direction for threaded connection in a passage in a forward end of a shaft received in the tubing drawn through the ~~drawing die~~ orifice.

9. (Original) The plug tool recited in claim 1 wherein said plug body includes a bore extending longitudinally therethrough coaxial with said central longitudinal axis.

10. (Original) The plug tool recited in claim 9 and further comprising

a connector having a head disposed at an end of a shank, said shank having a cylindrical length portion extending rearwardly from said head and a threaded length portion extending rearwardly from said cylindrical length portion, said shank being insertable in said bore with said head disposed externally of said plug adjacent a forward end of said plug body, said cylindrical length portion disposed in said bore, and with said threaded length portion extending rearwardly from said plug body for threaded connection in a passage in a forward end of a shaft received in the tubing drawn through the drawing die.

11. (Currently Amended) A plug tool for forming internally helically ribbed tube, comprising

a plug including a plug body for being rotatably disposed in a die orifice of a drawing die and having a central longitudinal axis, a plurality of external grooves equally spaced about said central longitudinal axis, and a plurality of external lands in alternating arrangement with said grooves, each of said plurality of grooves terminating at a forward groove end and at a rearward groove end on said plug body, each of said plurality of lands terminating at a forward land end and at a rearward land end on said plug body, said grooves extending longitudinally along said plug body at a helix angle to said central longitudinal axis and corresponding to internal helical ribs formed in tubing drawn longitudinally over and relative to said plug body in a forward direction through the drawing die with orifice as said plug body disposed rotates within the die orifice and the tubing, each of said grooves having a cross-section normal to said groove defined by a root surface and a pair of flank surfaces extending angularly outwardly away from one another from said root surface to land surfaces of adjacent ones of said lands, said root surface having a width in said cross-section defined between first and second radii, a rearward one of said flank

surfaces being disposed angularly offset from said first radii at a first angle to said first radii in said cross-section in a direction opposed to the forward direction of draw for the tubing over said plug body, and a forward one of said flank surfaces being disposed angularly offset from said second radii at a second angle, smaller than said first angle, to said second radii in said cross-section in a direction toward the forward direction of draw for the tubing over said plug body.

12. (Currently Amended) A The plug tool recited in claim 11 for forming internally helically ribbed tube, comprising

a plug including a plug body for being rotatably disposed in a die orifice of a drawing die and having a central longitudinal axis, a plurality of external grooves equally spaced about said central longitudinal axis, and a plurality of external lands in alternating arrangement with said grooves, said grooves extending longitudinally along said plug body at a helix angle to said central longitudinal axis and corresponding to internal helical ribs formed in tubing drawn in a forward direction through the drawing die with said plug body disposed within the tubing, each of said grooves having a cross-section normal to said groove defined by a root surface and a pair of flank surfaces extending angularly outwardly away from one another from said root surface to land surfaces of adjacent ones of said lands, said root surface having a width in said cross-section defined between first and second radii, a rearward one of said flank surfaces being disposed at a first angle to said first radii and a forward one of said flank surfaces being disposed at a second angle, smaller than said first angle, to said second radii, wherein said helix angle is 40°, said first angle is 37° and said second angle is 16°.

13. (Original) The plug tool recited in claim 11 wherein each of said

land surfaces has a width and said width of said land surfaces is at least substantially the same as said width of said root surfaces.

14. (Original) The plug tool recited in claim 13 wherein said width of said root surfaces is in the range of about 3.9mm to about 4.3mm.

15. (Currently Amended) A The plug tool recited in claim 4 for forming internally helically ribbed tube, comprising
a plug including a plug body for being rotatably disposed in a die orifice of a drawing die and having a central longitudinal axis, a plurality of external grooves equally spaced about said central longitudinal axis, and a plurality of external lands in alternating arrangement with said grooves, said grooves extending longitudinally along said plug body at a helix angle to said central longitudinal axis and corresponding to internal helical ribs formed in tubing drawn in a forward direction through the drawing die with said plug body disposed within the tubing, each of said grooves having a cross-section normal to said groove defined by a root surface and a pair of flank surfaces extending angularly outwardly away from one another from said root surface to land surfaces of adjacent ones of said lands, said root surface having a width in said cross-section defined between first and second radii, a rearward one of said flank surfaces being disposed at a first angle to said first radii and a forward one of said flank surfaces being disposed at a second angle, smaller than said first angle, to said second radii. each of said land surfaces having a width, said width of said land surfaces being at least substantially the same as said width of said root surfaces , said width of said root surfaces being in the range of about 3.9mm to about 4.3mm, wherein said grooves have a depth and said depth of said grooves is in the range of about 1.3mm to about 1.6mm.

16. (Currently Amended) A The plug tool recited in claim 11 for forming internally helically ribbed tube, comprising a plug including a plug body for being rotatably disposed in a die orifice of a drawing die and having a central longitudinal axis, a plurality of external grooves equally spaced about said central longitudinal axis, and a plurality of external lands in alternating arrangement with said grooves, said grooves extending longitudinally along said plug body at a helix angle to said central longitudinal axis and corresponding to internal helical ribs formed in tubing drawn in a forward direction through the drawing die with said plug body disposed within the tubing, each of said grooves having a cross-section normal to said groove defined by a root surface and a pair of flank surfaces extending angularly outwardly away from one another from said root surface to land surfaces of adjacent ones of said lands, said root surface having a width in said cross-section defined between first and second radii, a rearward one of said flank surfaces being disposed at a first angle to said first radii and a forward one of said flank surfaces being disposed at a second angle, smaller than said first angle, to said second radii, wherein said plug body is made of tool steel hardened and triple tempered to about 63RC.

17. (Original) The plug tool recited in claim 16 and further comprising a deposition of titanium nitride on said plug.

18. (Original) The plug tool recited in claim 16 and further comprising a coating of mono-molecular diamond on said plug.

19. (Original) The plug tool recited in claim 16 and further

comprising a coating of titanium nickel carbide on said plug.

20. (Currently Amended) A plug tool for forming internally helically ribbed tube, comprising

a plug including a plug body for being rotatably disposed in a die orifice of a drawing die and having a central longitudinal axis, a forward end, a rearward end, a plurality of external grooves equally spaced about said central longitudinal axis, and a plurality of external lands in alternating arrangement with said grooves, said grooves extending longitudinally along said plug body at a helix angle to said central longitudinal axis and corresponding to internal helical ribs formed in tubing drawn longitudinally over and relative to said plug body from said rearward end of said plug body toward said forward end of said plug body in a forward direction through the ~~drawing die with~~ orifice as said plug body ~~disposed~~ rotates within the die orifice and the tubing, each of said grooves having an asymmetrical cross-section normal to said groove defined by a root surface, a rearward flank surface extending angularly outwardly from said root surface at a first radial angle toward said rearward end of said plug body and a forward flank surface extending angularly outwardly from said root surface at a second radial angle, less than said first radial angle, and in a direction opposite said rearward flank surface;

an elongate shaft extending rearwardly from said plug body for being received in the tubing being drawn through the ~~drawing die~~ orifice and having a forward end for being coupled to said plug body; and

a connector for coupling said plug body to said forward end of said shaft for rotation of said shaft as one with said plug body when said plug body rotates ~~in~~ within the die orifice and the tubing about said central longitudinal axis.

21. (Currently Amended) The plug tool recited in claim 20 wherein said shaft comprises an axial threaded passage therein at said forward end of said shaft and said connector comprises an externally threaded extension extending coaxially from a said rearward end of said plug body for threaded engagement in said passage.

22. (Original) The plug tool recited in claim 21 wherein said extension is integral and unitary with said plug body.

23. (Currently Amended) ~~A~~ The plug tool recited in claim 21 for forming internally helically ribbed tube, comprising

a plug including a plug body for being rotatably disposed in a die orifice of a drawing die and having a central longitudinal axis, a plurality of external grooves equally spaced about said central longitudinal axis, and a plurality of external lands in alternating arrangement with said grooves, said grooves extending longitudinally along said plug body at a helix angle to said central longitudinal axis and corresponding to internal helical ribs formed in tubing drawn in a forward direction through the drawing die with said plug body disposed within the tubing, each of said grooves having an asymmetrical cross-section normal to said groove defined by a root surface, a rearward flank surface extending angularly outwardly from said root surface at a first radial angle and a forward flank surface extending angularly outwardly from said root surface at a second radial angle, less than said first radial angle, and in a direction opposite said rearward flank surface;

an elongate shaft for being received in the tubing drawn through the drawing die and having a forward end for being coupled to said plug body; and a connector for coupling said plug body to said forward end of said shaft

for rotation of said shaft as one with said plug body when said plug body rotates in the die orifice about said central longitudinal axis, wherein said plug body has an axial bore extending entirely therethrough and said connector comprises a head and a shank extending from said head, said shank having an externally threaded portion, said shank being insertable in said bore with said externally threaded portion extended coaxially from said rearward end of said plug body to define said extension.

24. (Original) The plug tool recited in claim 23 wherein said head defines a forward abutment at a forward end of said plug body and said forward end of said shaft defines a rearward abutment at said rearward end of said plug body and said plug body is confined in the axial direction between said forward and rearward abutments.

25. (Original) The plug tool recited in claim 23 wherein said connector comprises a socket head cap screw.

26. (Original) The plug tool recited in claim 20 wherein said shaft comprises a back-bar having a forward end defining said forward end of said shaft.

27. (Original) The plug tool recited in claim 20 wherein said shaft comprises a back-bar and an adapter connected to said back-bar, said adapter having a forward end defining said forward end of said shaft.

28. (Original) The plug tool recited in claim 27 wherein said back-bar has an outer diameter to fit within the tubing and said adapter has an outer

diameter to fit more closely within the tubing than said outer diameter of said back-bar.

29. (Original) The plug tool recited in claim 20 and further comprising a guide tube receiving said elongate shaft, said guide tube having an inner diameter to accommodate the tubing in which said shaft is disposed.

30. (Currently Amended) A plug tool for forming internally helically ribbed tube, comprising

a plug including a plug body for being rotatably disposed in a die orifice of a drawing die and having a central longitudinal axis, a plurality of external grooves equally spaced about said central longitudinal axis, and a plurality of external lands in alternating arrangement with said grooves, said plug body being constrained against longitudinal movement in the drawing die, said grooves extending longitudinally along said plug body at a helix angle to said central longitudinal axis and closely corresponding to internal helical ribs formed in tubing being drawn longitudinally over and relative to said plug body in a forward direction through the drawing die with orifice as said plug body disposed rotates within the die orifice and the tubing, each of said grooves having an asymmetrical cross-section normal to said groove defined by a root surface and a pair of flank surfaces extending from said root surface to land surfaces of adjacent ones of said lands, each of said grooves having a width at said root surface and between said flank surfaces, each of said lands having a width substantially equal to said width of said grooves, each of said pair of flank surfaces comprising a rearward flank surface angled from said root surface in a direction opposed to the forward direction of draw for the tubing over said plug body and a forward flank surface angled from said root surface toward the

forward direction of draw for the tubing over said plug body, said forward flank surfaces being steeper than said rearward flank surfaces.

31. (Original) The plug tool recited in claim 30 wherein said width of each of said grooves is defined between radii of said central longitudinal axis.

32. (Currently Amended) A The plug tool recited in claim 30 for forming internally helically ribbed tube, comprising

a plug including a plug body for being rotatably disposed in a die orifice of a drawing die and having a central longitudinal axis, a plurality of external grooves equally spaced about said central longitudinal axis, and a plurality of external lands in alternating arrangement with said grooves, said grooves extending longitudinally along said plug body at a helix angle to said central longitudinal axis and closely corresponding to internal helical ribs formed in tubing being drawn in a forward direction through the drawing die with said plug body disposed within the tubing, each of said grooves having an asymmetrical cross-section normal to said groove defined by a root surface and a pair of flank surfaces extending from said root surface to land surfaces of adjacent ones of said lands, each of said grooves having a width at said root surface and between said flank surfaces, each of said lands having a width substantially equal to said width of said grooves, said width of each of said grooves being defined between radii of said central longitudinal axis, wherein each of said grooves has a rearward one of said flank surfaces defining an angle of 37° with one of said radii and a forward one of said flank surfaces defining an angle of 16° with the other of said radii.

33. (Currently Amended) A method of producing internally ribbed tube,

comprising the steps of

drawing a length of plain tubing longitudinally in a forward direction over a longitudinally constrained plug body rotatably disposed in a die orifice of a drawing die and having a plurality of external grooves at equally spaced locations about a central longitudinal axis of the plug body and extending longitudinally at a helix angle to the central longitudinal axis in alternating arrangement with a like plurality of external lands, wherein each groove has a root surface and a pair of forward and rearward flank surfaces extending from the root surface at different radial angles in opposite directions from one another to the land surfaces of a pair of adjacent ones of the lands, wherein the radial angle of the forward flank surfaces extends toward the forward direction of draw for the tubing over the plug body and is less than the radial angle of the rearward flank surfaces such that the forward flank surfaces are steeper than the rearward flank surfaces; and constricting the tubing in the drawing die to force an internal surface of the tubing into the external grooves of the plug body to form a plurality of continuous helical ribs extending longitudinally along the internal surface in correspondence to the external grooves.

34. (Original) The method recited in claim 33 wherein said step of drawing is a second drawing step and further including, prior to said second drawing step, the steps of drawing the tubing over a plain plug in a first drawing step and annealing the tubing subsequent to said first drawing step and prior to said second drawing step.

35. (Original) The method recited in claim 34 and further comprising, subsequent to said second drawing step, the steps of heat treating the tubing, straightening the tubing and cutting the tubing into tubes of desired length

36. (Original) The method recited in claim 35 and further including the steps of subjecting the tubing to wet preparation prior to said first drawing step and subsequent to said first drawing step and prior to said second drawing step, and removing points and tails from the tubing subsequent to said second drawing step and prior to said heat treating step.

37. (Original) The method recited in claim 36 and further including, subsequent to said step of cutting, the steps of applying corrosion protection to the tubes, capping the ends of the tubes, bundling the tubes, documenting the tubes, labeling the tubes, storing the tubes and shipping the tubes to a designated site.

38. (Original) The method recited in claim 36 wherein said step of subjecting the tubing to wet preparation includes the steps of chemically descaling the tubing, passivating the surface of the tubing, soaping the tubing and drying the tubing.

39. (Original) The method recited in claim 38 wherein said step of chemically descaling comprises applying a sulphuric acid solution to the tubing.

40. (Original) The method recited in claim 38 wherein said step of

passivating comprises applying a phosphate solution to the tubing.

41. (New) The plug tool recited in claim 1 wherein said plug body is caused to rotate within the die orifice and the tubing in response to the tubing being drawn longitudinally over said plug body in the forward direction through the die orifice.

42. (New) The plug tool recited in claim 1 wherein said angle of said rearward flank surfaces is a radial angle of about 37° and said angle of said forward flank surfaces is a radial angle of about 16° .

43. (New) The plug tool recited in claim 11 wherein said first angle is about 37° and said second angle is about 16° .

44. (New) The plug tool recited in claim 20 wherein said first radial angle is about 37° and said second radial angle is about 16° .

45. (New) The plug tool recited in claim 30 wherein said rearward flank surfaces define an angle of about 37° with one of said radii and said forward flank surfaces define an angle of about 16° with the other of said radii.